Main Entry: **he·lix**
Pronunciation: 'hE-liks
Function: *noun*
Inflected Form(s): *plural* **he·li·ces** /'he-l&-"sEz, 'hE-/ *also* **he·lix·es** /'hE-lik-s&z/
Etymology: Latin, from Greek; akin to Greek *eilyein* to roll, wrap —more at VOLUBLE
Date: 1563
1 : something spiral in form: as **a :** an ornamental volute **b :** a coil formed by winding wire around a uniform tube
2 : the incurved rim of the external ear
3 : a curve traced on a cylinder or cone by the rotation of a point crossing its right sections at a constant oblique angle; *broadly* : SPIRAL 1b

Pronunciation Key

Main Entry: [2]spiral
Function: *noun*
Date: 1656
1 a : the path of a point in a plane moving around a central point while continuously receding from or approaching it **b :** a three-dimensional curve (as a helix) with one or more turns about an axis
2 : a single turn or coil in a spiral object
3 a : something having a spiral form **b (1) :** a spiral flight **(2) :** a kick or pass in which a football rotates on its long axis while moving through the air
4 : a continuously spreading and accelerating increase or decrease <wage *spirals*>

Pronunciation Key

BACKGROUND OF THE INVENTION

The present invention relates to a device for sterilizing plastic and/or metal parts intended for stoppering bottles which is less expensive than those currently used, and which is capable of considerably extending the sterilization time duration. The present invention also relates to the production of a bottling plant that can be modified at will.

SUMMARY OF THE INVENTION

In accordance with the present invention, these objectives are achieved by providing a machine for sterilizing plastic and/or metal stoppering parts for bottles which is installed on a bottling line, upstream of the screwing machine, and which operates at the same rate as that of the screwing machine. The stoppering parts are introduced unsterilized into an inlet at one end of the sterilizing machine and emerge sterilized through an outlet at the other end of the sterilizing machine. The path followed by the parts between the inlet and the outlet of the sterilizing machine, and within the unit, is a helical path. The stoppering parts are set in motion by friction against a rotating member or by a driving fluid. The machine of the present invention carries out at least the functions of sterilizing and rinsing, depending on the alternative embodiment

used, and also carries out a pre-drying or drying function.

A first alternative embodiment of a sterilizing machine produced in accordance with the present invention comprises three successive and coaxial sections, including sterilizing, rinsing and drying sections. Each of these sections has the same axis as the helix of the path for the stoppering parts, and the following preferred characteristics.

The parts are preferably set in motion along their path by friction against a rotating member. More particularly, the parts are set in motion by a conveying system formed of a hollow cylindrical sleeve which can rotate around a helical slideway which is secured to a stationary drum and which is wound around the exterior wall of the drum. The slideway has a U-shaped profile which is open toward the sleeve, and a height which is shorter than that of the stoppering parts, so that the friction between the rotary drum and the stoppering parts introduced into the slideway causes the parts to move along the path.

In the sterilizing section, the bottom of the helical screw preferably comprises a large number of holes through which a large number of nozzles, situated inside the stationary drum and preferably in its upper part, inject a sterilizing solution. The holes are preferably oriented in a direction which is inclined with respect to a radius of the drum.

The sterilizing liquid is preferably collected in the lower part of the stationary drum, in a suction cavity which is offset with respect to the vertical plane of symmetry of the

drum. The liquid is then offset by the rotation of the rotary drum. Arrangements are made to prevent the liquid from running over the ends of the drum.

Preferably, the sterilizing liquid is drawn through a pipe, filtered in filtration means, reheated by heating means, and then recycled. Transitions between the several sections are preferably provided by arrangements of the helical slideway. The sterilizing solution is preferably injected by a nozzle into a pressure-equalizing chamber formed by a wall parallel to a wall of the stationary drum. A groove is provided on the interior face of the rotary drum in which the central cap of the parts can slide.

Two other alternative embodiments of a sterilizing machine produced in accordance with the present invention set the stoppering parts in motion using a driving fluid. The driving fluid is selected from the group of fluids including compressed air, pulsed filtered air and sterilizing liquid.

The parts preferably travel in a conveying system which is formed of a hollow and stationary cylindrical sleeve surrounding a helical slideway secured to a stationary drum and wound on the exterior wall of the drum. The sole of the slideway has openings for the injection of driving fluid. The slideway is preferably made by a profiled separation which is positioned and welded into a helical groove made on the stationary drum. The sole is preferably a flexible metal strip which is wound between the separations and held by tension at its ends, resting on two

shoulders of the separation.

The sterilizing machine is preferably made of modules of identical design which are assembled in series and closed at both ends. At least one slit is preferably provided at the outlet of each module, and on its sleeve, to encourage the driving fluid to be sucked up into an annular manifold. The liquid is preferably recycled into the inlet tube.

Depending on need, the longitudinal axis of the machine is arranged vertically for vertical operation, or is arranged horizontally for horizontal operation.

In one of its alternative forms, the machine comprises a standard module with several turns. The upper part of the last turn of the module carries out a rinsing function, with air. The previous turns, or the front turns of the module, perform a sterilizing function.

Preferably, orifices for the passage of liquid-injection nozzles oriented at a driving angle are provided in the sole of each front turn. One of the orifices is preferably provided in the bottom part of each turn on the vertical plane of symmetry.

Preferably, a cylinder is coaxial with the cylindrical sleeve and delimits a cylindrical discharge space. The cylindrical sleeve preferably has oblong-shaped discharge holes.

Preferably, an air inlet inside the module distributes air to at least one air-injection nozzle for driving the stoppering parts. The air is then distributed to at least a second air-injection nozzle, which performs internal rinsing of

the stoppering parts. The air is then distributed to at least a third air-injection nozzle, which performs external rinsing of the stoppering parts.

It is to be understood that the foregoing preferred but non-limiting characteristics can be applied individually or in combination. The invention will be better understood with reference to the description which follows, together with the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic side view showing a first alternative embodiment of the sterilizing machine of the present invention.

Figure 2 is a schematic view showing the stationary drum and the conveying slideway.

Figure 3 is a schematic view showing the conveying assembly in vertical cross-section, taken in the sterilizing section.

Figure 4 is a detailed view of the conveying assembly, along its upper part.

Figure 5 is a detailed view of the conveying assembly, along its lower part.

Figure 6 is a schematic side view showing a second alternative embodiment of the sterilizing machine of the present invention.

Figure 7 is a schematic, sectional view showing the stationary drum and the conveying slideway of the alternative embodiment shown in Figure 6.

Figure 8 is a schematic view showing the conveying assembly in vertical cross-section, taken in the sterilizing section.

Figure 9 is a detailed view of the conveying assembly shown in Figure 8, along its upper part.

Figure 10 is a detailed view of the conveying assembly shown in Figure 8, along its lower part.

Figure 11 is a cross-sectional view taken along BB in Figure 9.

Figures 12 to 18 are schematic views showing alternative arrangements of the rotary drum.

Figures 19a and 19b are schematic views showing alternative embodiment transitions between sections.

Figures 20a and 20b are detailed views of the conveying assembly used for "sports stoppers".

Figure 21 is a schematic, sectional view showing a third alternative embodiment of the sterilizing machine of the present invention.

Figures 22, 22a and 22b are detailed views of the alternative embodiment shown in Figure 21.

Figure 23 schematically illustrates the steps of a method in accordance with the present invention.

Figures 24 and 25 are schematic diagrams of a standard

module used in a fourth alternative embodiment of the sterilizing machine of the present invention.

Figure 26 is a schematic illustration of a sterilizing plant comprising the sterilizing machine shown in Figures 24 and 25.

Figure 27 is a front view of the sterilizing plant shown in Figure 26.

Figure 28 is a detailed view of a sterilizing liquid injection nozzle.

Figure 29 is a vertical cross-sectional view of one of the front turns of a standard sterilizing-rinsing module.

Figure 30 is a partial, cross-sectional view taken along AA in Figure 29.

Figure 31 is a view, in vertical and transverse cross-section, of the upper part of the last turn of a standard sterilizing-rinsing module.

DETAILED DESCRIPTION OF THE INVENTION

Reference is first made to Figures 1 to 5, which show a first alternative embodiment of the sterilizing device of the present invention.

The sterilizing device (1) of the present invention is installed on a bottling line, upstream of the screwing machine which is a conventional part of the bottling line, and operates at the same rate as that of the screwing machine. The sterilizing

device (1) essentially comprises three successive and coaxial sections including a sterilizing section (2), a rinsing section (3) and a drying zone (4).

Figures 1 to 5 show a first alternative embodiment of the sterilizing device (1) of the present invention, operating horizontally. The device (1) includes a conveying assembly (5) formed of a hollow cylindrical sleeve (6) which can move in rotation around a helical slideway (7). The slideway (7) is secured to and wound around the exterior wall of a stationary drum (8). The slideway (7) has a U-shaped profile which is open toward the sleeve (6). The sleeve or rotary drum (6) and the stationary drum (8) are coaxial.

An inclined straight part, forming an inlet slideway (9), extends from one end of the stationary drum (8). Unsterilized stoppering parts (11) are all oriented in the same direction in the inlet slideway (9), and drop down toward the bottom to enter the conveying assembly. Another straight part, which is also inclined, extends from the other end of the stationary drum (8), forming an outlet slideway (10). The stoppering parts (11) are directed downward, and are all oriented in the same direction as in the inlet slideway (9).

The slideway (7) is appreciably shorter in height (see Figures 9 and 11) than the stoppering parts (11) to allow them to protrude from the slideway (7). Friction between the rotary drum (6) and the stoppering parts (11) causes the stoppering parts to move in the slideway (7), driving them toward the exit slideway

(10).

The interior surface of the rotary drum (6) can, for example, be smooth, striated with grooves parallel to the axis of rotation, or striated with grooves in a helix formed parallel to the axis (12) of the stationary slideway (7) (see Figure 12).

The configuration of the internal conveying assembly (5) develops a path for the stoppering part (11) which is considerably lengthened in comparison to the length of the stationary drum (8). As an example, a stoppering part (11) will typically travel a length of 35 m for a sleeve length of 1 m.

In the sterilizing section (2) (see Figures 2 and 4), the bottom (13) of the helical screw developed by the slideway (7) includes a large number of holes (14), and a large number of nozzles (15) pass through the holes (14). The nozzles (15) are situated inside the stationary drum (8), preferably in its upper part, and inject a liquid, gaseous and/or hot sterilizing solution. The holes (14) preferably are not directed radially, but are directed in an orientation which is inclined, for example, by an angle α = from 10 to 20°, with respect to a radius of the drum. In this way, jets (16) of sterilizing solution can play a part in moving the stoppering parts (11).

As is shown in Figure 5, the sterilizing liquid is preferably collected at the lower part of the stationary drum (8), in a suction cavity (17). The suction cavity (17) is offset with respect to the vertical plane of symmetry of the drum, and

the liquid is offset by rotation of the rotary drum (6).

Arrangements can be made to prevent the liquid from running over the ends of the rotary drum. As an example, the rotary drum (6) shown in Figures 13, 14a and 14b has rigid circular returns (18) at each end, the height of which exceeds the level (12) of liquid to be held back. In this embodiment, the inlet slideway (19) will need to be elbowed at (19) to pass around the return (18). As an alternative, the returns (18) shown in Figure 17 are made of an elastomer, or some other flexible material. A separating finger (21) can be provided in line with the arrival of the inlet slideway (9). As another alternative, shown in Figure 15, the entire rotary drum (6) assembly can be immersed in a tank (20). As another alternative, shown in Figure 16, the entire drum assembly can be inclined and one of its ends can be immersed in the tank (20). As another alternative, shown in Figure 18, the radius of gyration of the slideway (7) can also be varied in line with the inlet and the outlet of the rotary drum (6).

The sterilizing liquid is first sucked up by a pipe (18a) (see Figure 1). The sterilizing liquid is then filtered in filtration means (22), then reheated by heating means (23), and then recycled.

The rinsing section (3) and the drying section (4) each have a conveying assembly constructed on the same principle as the conveying assembly (5) in the sterilizing section (2). Transitions between sections can be accomplished by arrangements

of the slideway (7), for example, by varying the pitch diameter of the slideway (7), which in this case is a one-piece construction (see Figure 19a), or by varying the pitch diameter and increasing the pitch (see Figure 19b), in order not to reduce the radius of gyration, in which case the slideway will be visible.

The supporting structures and the mechanical drive means shown (for example, the motor (30), the rollers (31), etc.) are known components within the competence of persons skilled in the art.

Figures 6 to 11 show a second alternative embodiment. The embodiment shown in Figures 6 to 11 essentially differs from the embodiment shown in Figures 1 to 5 in the form of the support structure (24), in the transition between adjacent sections, and by increasing the pitch of the helical slideway. The embodiment shown in Figures 6 to 11 also includes inspection hatches (25), which can also be provided on the embodiment shown in Figures 1 to 5.

Referring to Figure 9, the sterilizing solution is injected by a nozzle (15) into a pressure-equalizing chamber (26) formed by a wall (27) which is located parallel to the inside surface of the stationary drum (8). Figure 11, viewed in section along BB in Figure 9, shows stoppering parts in two successive loops of the slideway. Such embodiments can be modified for sterilizing "sports" stoppers which have a central cap (29) projecting from the lid. In this case (figures 20a and 20b), straight grooves or channels parallel to the axis of rotation

(28), and in which the central cap of the parts slides, are provided on the interior face of the rotary drum (6).

Reference is now made to Figures 21 to 23, which show a third alternative embodiment of the sterilizing device of the present invention. Although this embodiment is depicted operating vertically, from top to bottom, the direction of operation could also be reversed, and provision could also be made for this embodiment to operate horizontally, in one direction or the other.

In the embodiment shown in Figures 21 to 23, the parts are set in motion by a driving fluid injected into the device. The path between the inlet E and the outlet S of the device remains a helical path. The driving fluid is, for example, filtered air injected under pressure or blown in by a fan.

The stoppering parts travel in a conveying system (5) formed of a hollow and stationary cylindrical sleeve (101). The sleeve (101) is coaxial with a stationary drum (102), forming a support for a conveying helical slideway (107) arranged in the space between the sleeve (101) and the drum (102). The hollow cylindrical sleeve (101) surrounds a helical slideway which is secured to a stationary drum and which is wound on the exterior wall of the drum. The sole (103) of the slideway has openings for injection of the driving fluid.

As an example, Figures 21 and 22 show a helical slideway which is produced using a profiled separation (107a) positioned and welded into a helical groove made on the exterior

surface of the stationary drum (102) (see Figure 22a). The bottom of the slideway, known as the sliding sole (103), is formed of a flexible metal strip wound in a spiral between the separations (107a), and held by tension at its two ends. The two edges of the sliding sole (103) rest on two shoulders (107b) provided on each side of the separation (107a) (see Figure 22a).

The resulting plant is preferably modular, as shown in Figures 21 and 22, meaning that the sterilizing section (108), the rinsing section (109) and the drying section (110) are modules of identical design. The modules are assembled in series by fastening means (104), and are closed at both ends by an inlet wall (111) and by an outlet wall (112). A single sliding sole is preferably used for all of the modules.

The modules differ, according to their function, in terms of the fluid to be conveyed. Depending on whether a module is used as a sterilizing section, as a washing section or as a drying section, tubes (106 or 106') internal to the drum (102) and parallel to the longitudinal axis of the drum (102) deliver sterilizing fluid or driving fluid (for example, delivering liquid through the tube (106) and delivering sterile air through the tube (106')).

The fluid is, for example, injected into a pressure chamber (105) by nozzles (114), the delivery of which can be adjusted by adjusting means (114b). The nozzles (114) pass through the drum (102) via rectangular slits (114a). From one to four nozzles per turn can be provided (see Figures 21, 22, 22a

and 22b). The fluid then passes through the sliding sole through openings (113) which direct the jet of fluid in the direction of travel of the stoppering parts (see Figure 22a). The geometry of the openings (113), which is, for example, triangular (113a) or trapezoidal (113b), is per se known.

One (or more) suction slits (116) (see Figure 22a) are provided at the outlet end of each module, on the stationary sleeve (101), to encourage the driving fluid to be drawn into an annular manifold (115a) (see Figures 22a and 21) by suction means (117). The suction slits (116) are preferably inclined, for example, at 45°. The withdrawn fluid will then be recycled in a fluid/air separator (119) (see Figure 21).

A hopper (120, 120') for collecting parasitic rejections of fluids inside the drums is provided at the outlet of each module (see Figure 21). Such rejections are carried away by concentric tubes (121, 121') to a filter (122). The filter (122) also collects fluid leaving a tube (123) exiting from the separator (119) (see Figure 21). Fluid from the filter (122) is pumped by a recycling pump (124), and is taken to a reservoir (125). Fluid from the reservoir (125) is then recycled by an inlet pump (126) into the inlet tube (106).

A modular plant has many advantages, particularly the following. Modularity allows an existing plant to be modified, for example, by adding modules if the sterilizing is insufficient. Modularity also makes it possible, using standard elements, to produce a plant tailored to local means. Modularity

also allows a process to be carried out using the plant to be modified.

Figure 23 illustrates one of many examples of the steps which can make up a sterilizing method in accordance with the present invention. The illustrated steps include introducing the stoppering parts into the inlet (at E), injecting sterilizing liquid (liquid phase) (at A), injecting driving fluid (at B), discharging (outlet) the sterilizing liquid (at C), injecting pure water (at D), injecting driving fluid (at H), discharging (outlet) the water (at F), drying the stoppering parts with air (at G), discharging (outlet) the air (at I), and discharging (outlet) the stoppering parts (at F).

Reference is now made to Figures 24 to 30, which show a fourth alternative embodiment of the sterilizing device of the present invention.

Figure 26 diagrammatically shows the installation of a sterilizing-rinsing device (201) produced in accordance with the present invention in a sterilizing plant (202) which is situated upstream of a bottling line (203). In the plant (202), stoppering parts (213) are delivered from a magazine (204) which orients and distributes the stoppering parts (213). The stoppering parts (213) are then conveyed by an inlet slideway (214) to a sterilizing-rinsing device (201). The stoppering parts (213) travel in the sterilizing-rinsing device (201) in a helical path (215) under the effect of a driving fluid, and then leave the sterilizing-rinsing device (201) via an outlet slideway (216).

The slideway (216) is fitted with a regulator (205) which determines the outlet speed of the stoppering parts (213) according to the rate needed for the bottling line (203). Also illustrated is the casing of a charging machine (203a) and a screwing machine (203b).

Figures 26 and 27 show only the main components of the sterilizing liquid circuit, including the reservoir (206), the pump (207), the filters (208), and the inlet (209) for introducing liquid into the device (201). The inlet (209) splits into a number of injection pipes (210), for example three, each supplying a liquid-injection nozzle (211a, 211b, 211c). For the compressed air circuit, only the locations of the air injection nozzles (212a, 212b) have been shown.

The sterilizing-rinsing device (201) of the fourth alternative embodiment which is schematically shown in Figures 24 and 26 is manufactured as a standard module that meets predetermined standard sterilization criteria. The helical path of the illustrated standard module includes, as an example, six contiguous turns. The upper part of the last turn (or rear turn) performs the function of rinsing with air. The previous turns (or front turns) perform the sterilizing function using a sterilizing liquid injected through a number of liquid-injection nozzles, for example, three such nozzles (211a, 211b, 211c) per turn.

The U-shaped slideway which forms the helical path (215) can be produced by the techniques previously described

for the third alternative embodiment. Also, as in the third alternative embodiment, the stoppering parts are conveyed through the standard module (201) between a stationary cylindrical sleeve (217) forming the outer envelope, a stationary sole (or bottom) (218) of the slideway, and two separating walls (219).

Within this path, the stoppering parts are set in motion by the sterilizing liquid, under pressure, which also acts as a driving fluid. For this, the nozzles are distributed uniformly over each turn and are oriented at a driving angle (ß) (see Figure 29). The driving angle (ß) shown in Figure 29, which corresponds to a detailed view of one of the front turns, is preferably measured tangentially to the sole of the turns.

Orifices (220a, 220b, 220c) are provided in the soles of the turns, for passage of the nozzles (211a, 211b, 211c). One of the orifices (220c) is preferably provided in the bottom part of each turn, on the vertical and longitudinal plane (221) of the module. A cylinder (222a) which is coaxial with the cylindrical stationary sleeve (217) defines, together with the bottoms of the turns (218), a cylindrical discharge space (222).

Excess sterilizing liquid is discharged through the two upper orifices (220a, 220b) of each turn. The discharged liquid flows into the cylindrical space (222), passes through the bottom orifices (220c) of the front turns, and then through the discharge holes (223) provided in the bottom of the outer cylindrical sleeve (217). The discharged liquid is then collected in a discharge tank (225).

The discharge holes (223) (see Figure 30) are preferably oblong in shape, with their longitudinal axis being placed at right angles to the vertical longitudinal plane (221) of the module and on the axes of the separations (219). In this way, the liquid is discharged through the more or less triangular gaps (224) which lie on each side of the separations (219) of the slideway between the stoppering parts (213).

Reference is now made to Figure 31, which shows the rinsing with air which is performed more or less in one half or one third of the upper part of the last turn. An inlet (223) for pressurized air is situated inside the module (201). The inlet (223) distributes air under pressure to a first air-injection nozzle (212a) (or to several air-injection nozzles) which discharges the air in the direction in which the stoppering parts (213) move. This operates to assume the function of a driving fluid, which function was performed by the sterilizing liquid in the bottom part of the turn, and which has been discharged. The air inlet (223) also distributes air to a second air-injection nozzle (212b) (or to several air-injection nozzles) which is situated toward the top of the last turn. The nozzle (212b) directs air toward the inside of the stoppering parts which travel past the nozzle (212b), rinsing the insides of the stoppering parts (213), one after the other. The outsides of the stoppering parts (213) are rinsed by one or more nozzles (212c) situated externally to the cylindrical sleeve (217).

In the upper part of the last turn performing such

rinsing, the stoppering parts (213) are driven by air, and then rinsed on the inside and on the outside (or vice versa). In this way, the stoppering parts (213) arrive partially dried in the outlet slideway. From the outlet slideway, the already partially dried stoppering parts (213) are directed toward a dryer (not shown) which will complete the drying of the stoppering parts (213). In order to regulate the exit speed of the stoppering parts (213), the regulator (205) can, for example, be a star-shaped rotary component (226) which is driven by a geared motor (227).